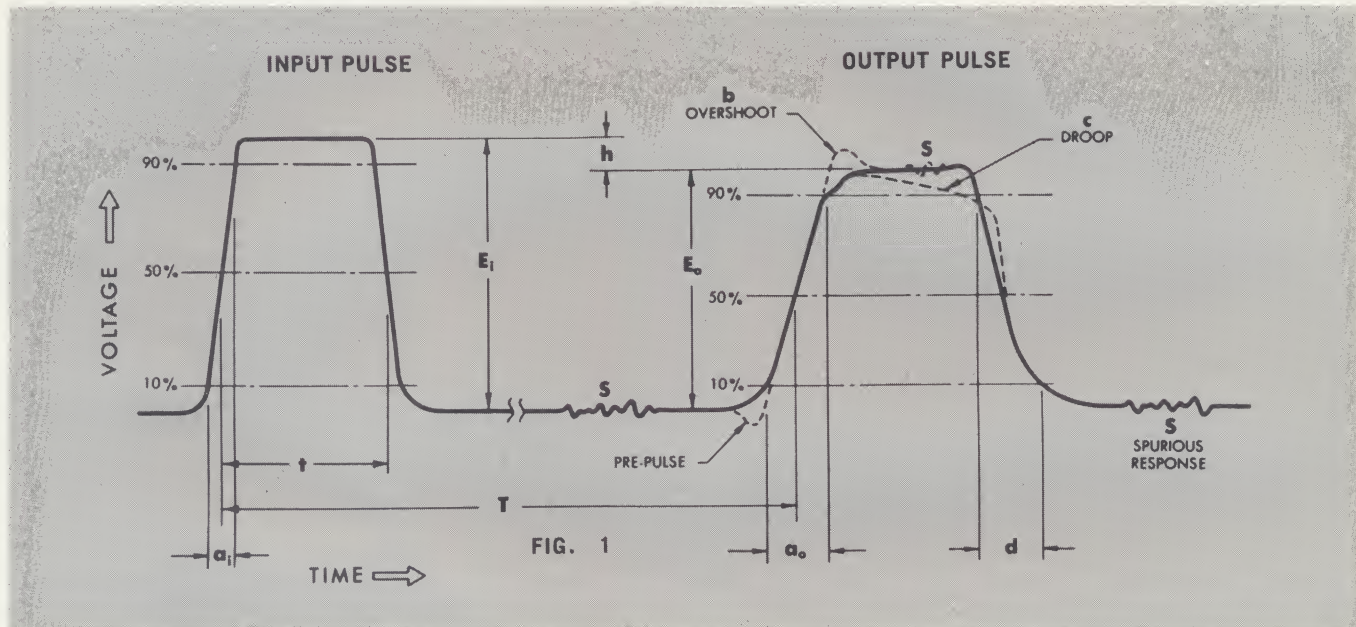


# Delay Lines

## Terminology

In order to evaluate and specify your delay line requirements, it is helpful to be familiar with the terminology. The terms most often used to describe and specify delay line characteristics are given below. Where appropriate they're shown on Fig. 1. Dashed lines show common variations in output waveshape.



### a RISE TIME...

$a_i$  Input pulse rise time

$a_o$  Output pulse rise time

$a_n$  Network pulse rise time

$$a_n = \sqrt{(a_o)^2 - (a_i)^2} \text{ approx.}$$

**b OVERSHOOT**...A continuation of the leading edge of the pulse

**c DROOP**...A sloping of the top of the pulse

**d FALL TIME**...

**h ATTENUATION** (in db) =  $20 \log \frac{E_i}{E_o}$

**s SPURIOUS RESPONSE**—Distortion—Ripple... Three common terms used to define any irregularities in the signal output of the delay line due to various causes. This may be expressed as db below  $E_o$

**t PULSE WIDTH**...Usually measured at 50% amplitude points.

**T DELAY TIME**...The pulse delay is usually measured from the 50% amplitude point of the leading edge of the input pulse to the 50% amplitude point of the leading edge of the output pulse.

**CHARACTERISTIC IMPEDANCE,  $Z_o$** ... Characteristic impedance of the delay line is the impedance presented to an input pulse applied to the delay line. A delay line is usually terminated in a resistance equal to the characteristic impedance.

**DELAY/RISE TIME RATIO,  $T/a_n$** ...The ratio of total delay to the delay line rise time is one measure of the quality of the delay line.

**BANDWIDTH**... Those frequencies which are passed at a useful amplitude (attenuated 3 db or less, for example). This is related to rise time approximately by

$$\text{bandwidth} \times \text{rise time} = .4$$

**TEMPERATURE COEFFICIENT**... Usually expressed as a percent change in delay per degree Centigrade.

**PHASE SHIFT**... Delay lines may be used as phase shifting devices. A delay line will shift the phase of a sine wave an amount in degrees equal to  $360 \times \text{delay time} \times \text{frequency of sine wave}$ .  $\theta = 360 \times T \times f$ .



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# High Frequency Delay Lines

Delay Lines for operation at frequencies up to 500 megacycles are now being developed and produced to meet special requirements. Control Electronics offers to fill your high frequency delay line requirements. We are able to fill all the environmental and tolerance specifications that are presently being met with our lumped constant delay lines at lower frequencies. These high frequency delay lines are available in fixed and variable types or can be tapped at various delay points. They are made to meet applicable military specifications.

Characteristics of delay lines, developed by Control Electronics, for high frequency application are shown in the following table.



**Model V215**  
**125 Mc/s bandwidth**

Characteristic	Model Number			
	V215	F258	F264	F272
Time Delay	0 to 50 n sec	10 n sec	50 n sec	200 n sec
Rise Time	—	—	10 n sec	16 n sec
Bandwidth	125 Mc/s	500 Mc/s	50 Mc/s	30 Mc/s
Impedance	50 ohms	50 ohms	100 ohms	120 ohms
Spurious	< 5%	< 3%	< 3%	< 3%
Attenuation (Pulse)	< 5%	< 1%	< 5%	< 10%
Terminals	BNC/Type N	BNC	WIRE LEADS	WIRE LEADS
Thermal Stability	50 PPM/°C	50 PPM/°C	50 PPM/°C	50 PPM/°C

Model V215 was specifically developed for use by the Radio Astronomy Station of the Harvard College Observatory in its Star Tracking experiments. It is designed for continuous motor driven application and is constructed with a rugged, printed circuit, commutator type switch having rhodium plated segments and a silver alloy wiper arm. Resolution is one part in 120.



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*military & commercial*

# DELAY LINES



MAGNETOSTRICTIVE ■ LUMPED CONSTANT ■ DISTRIBUTED CONSTANT



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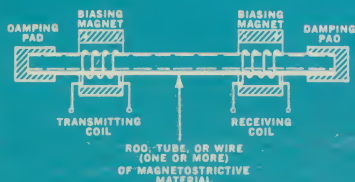
INTERNATIONAL SALES: EMEC Inc., 160 Terminal Drive, Plainview, N.Y. 11803  
CABLE: Electronic, Plainview NEWYORKSTATE



To keep pace with a constantly improving technology, CEC offers a complete series of **tested** and **proven** Delay Lines to meet every requirement. At CEC, many years of experience go into supplying consistently high performance at lowest possible cost. Delay Lines shown here the typical, and are merely indicative of the wide range offered by CEC . . . most deliverable from off-the-shelf stocks. Custom-designed units with varying size, weight, volume, terminal or mounting configuration, delay to rise time, bandwidth, VSWR, etc., are also available at low production prices. For simplified ordering, use the handy CEC Engineering-Specification Card.

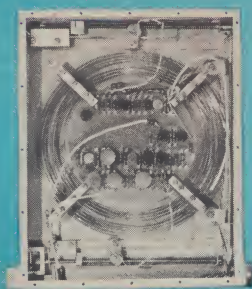
## MAGNETOSTRICTIVE DELAY LINES

In magnetostrictive delay, an electrical signal is converted into a sonic wave which travels through a treated nickel alloy wire and is re-converted to an electrical signal at the "far" end of the wire. The wire length is an accurate measure of the delay time. CEC Magnetostrictive Delay Lines feature substantially long delay capability (to 10,000 microseconds in one unit) and low temperature coefficients (1.0 ppm/°C). Write for specification sheet MS-6402.



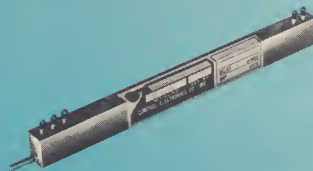
### MAGNETOSTRICTIVE DELAY SCHEMATIC

Conversion to a sonic wave, then reconversion to an electrical signal, attenuates the signal as much as 70 db. Most electronic circuits cannot afford to suffer a 70 db loss in signal strength. However, CEC offers Magnetostrictive Delay Lines either without or with unity gain circuits which restore signal strength to its original level. When several delay lines are stacked in series for increased delays, each delay line should include unity gain output circuits to restore signal to its original level at the output of each line.



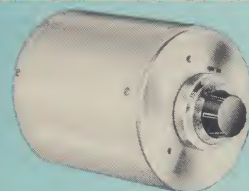
### FIXED DELAY MAGNETOSTRICTIVE LINE

Delays to 5,000 microseconds available in 6" x 6" x 1" case; to 10,000 microseconds in 8" x 8" x 1". Circuitry for unity gain included.



### SHORT DELAY — VARIABLE MAGLINES

Used as a variable or fixed delay line. Infinite resolution. Unique clutch arrangement at ends of stops. Ideal for PC boards.

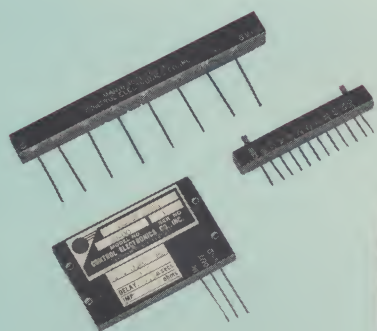


### LONG DELAY — VARIABLE MAGLINE, KNOB ADJUSTABLE

Up to 10,000 microseconds delay available in single units. Case dimension: 4" OD x 4½" long or 9" OD x 3½" long.

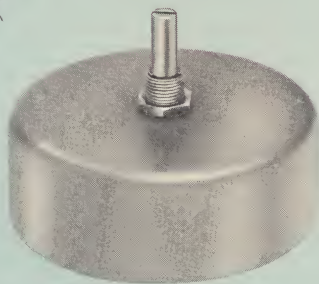
# LUMPED CONSTANT DELAY LINES

Lumped Constant Delay Lines offer microsecond delay times in extremely compact packages. Delay is achieved through the usual LC circuits which are matched and designed to offer minimum attenuation of signal . . . for use without additional amplification. Units are hermetically sealed with temperature coefficients of approximately 45 ppm/°C. Write for Specification Sheet LC-6404.



## COMPACT, FIXED DELAY LINE FOR PC BOARD APPLICATION— FULLY ENCAPSULATED

Many models with delays to 10 microseconds available . . . attenuation is only 1.0 db. All connections from one face for plugging into PC Board and dip soldering.



## MINIATURE ROTARY VARIABLE DELAY LINE

Only 3" diam. x 1" high unit provides a variable delay line with delays to 3 microseconds . . . resolution 1:120. Sixty position selector switch can be supplied with motor drive.



## STEP VARIABLE DELAY LINE

Delays to 12 microseconds available in 60 steps or less. Can be supplied with motor drive. Dimensions: 4 1/4" x 4 1/4" x 1 1/4".

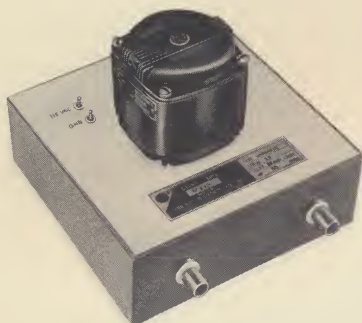


## MINIATURE VARIABLE DELAY LINES—TO 2 MICROSECONDS

Can operate at 500 vdc. Screwdriver delay adjustment shown at right end of unit. Dimensions: 4 3/4" x 1 1/2" x 1 1/2".

## HIGH FREQUENCY DELAY LINES

Delays with 500 Mc/s bandwidths available. Write for Specification Sheet HF-6401.



### MOTORIZED VARIABLE DELAY

With extraordinarily high bandwidth.

## AUDIO DELAY LINES

Delays to 100 milliseconds in one unit with excellent phase, attenuation, impedance and other specifications. Write for Specification Sheet AD-6402.



### CASCADED DELAY CABINET

Weighs only 200 lbs. Provides delay of 100 milliseconds (four 25 ms units) with taps at every 1 ms . . . within 1%. Bandwidth: 400 cps.

## DISTRIBUTED CONSTANT DELAY LINES

Distributed Constant Delay Lines employ a ground plane or metallic ribbon as the capacitance of an LC network . . . and are generally less expensive than Lumped Constant Delay Lines. Units are hermetically sealed with temperature coefficients of approximately 50 ppm/°C. Write for Specification Sheet DC-6401.



### SQUARE UNIT

For easy mounting to PC board. All connector pins extend from one surface.



### FIXED DELAY LINE

Compact and accurate with delays to 4 microseconds in this sections. Using several alternating "lines" running back and forth, any delay can be achieved.

Distributed by:

Postage  
Will be Paid  
by  
Addressee

No  
Postage Stamp  
Necessary  
If Mailed in the  
United States

**BUSINESS REPLY MAIL**

First Class Permit No. 297, Farmingdale, New York



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☐ SEND ADDITIONAL LITERATURE ON  
THE FOLLOWING TYPE DELAY LINE

fixed tapped variable

Lumped Constant ☐ ☐ ☐

Distributed " ☐ ☐ ☐

Magnetostrictive ☐ ☐ ☐

☐ All the above

☐ SEND A COPY OF "DELAY LINE  
TERMINOLOGY"

☐ HAVE REPRESENTATIVE CALL ON ME.

☐ RECOMMEND A DELAY LINE TO MEET THE FOLLOWING  
REQUIREMENTS AND QUOTE ON QUANTITIES OF \_\_\_\_

Delay \_\_\_\_ usec + \_\_\_\_ usec. With Taps at \_\_\_\_, \_\_\_\_, \_\_\_\_ usec  
Input Pulse: Width \_\_\_\_ usec. Rise Time \_\_\_\_ usec  
Input Current: \_\_\_\_ milliamps. Output Voltage: \_\_\_\_ millivolts  
Output Pulse: Rise Time \_\_\_\_ usec or Frequency \_\_\_\_  
Response \_\_\_\_ or Digital Bit Rate \_\_\_\_  
Impedance: Input \_\_\_\_ ohms. Output \_\_\_\_ ohms  
Attenuation: \_\_\_\_ db max. Spurious: \_\_\_\_ % max  
Thermal Coefficient: \_\_\_\_ PPM/°C. Temp. Range \_\_\_\_ °C to \_\_\_\_ °C  
If Variable: Range \_\_\_\_ usec to \_\_\_\_ usec. Resolution: \_\_\_\_  
Environmental Specs: \_\_\_\_

Maximum Size: \_\_\_\_

Other Requirements: \_\_\_\_

Mr. \_\_\_\_

Title or Position \_\_\_\_

Company \_\_\_\_

Address \_\_\_\_

Street \_\_\_\_

City \_\_\_\_

State \_\_\_\_

ZIP \_\_\_\_

Phone \_\_\_\_

Ext \_\_\_\_

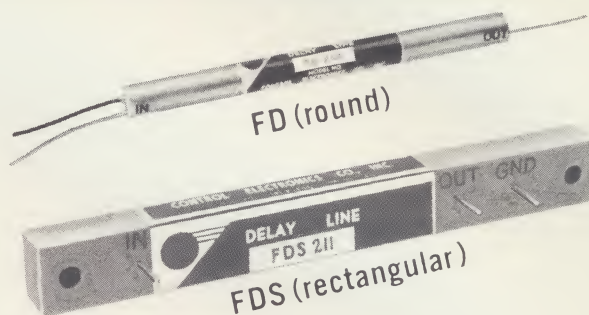
Engineering-Specification Card

# Distributed Constant Delay Lines

## GENERAL SPECIFICATIONS

for Standard and Custom Units

Construction	Encapsulated in Epoxy resin Moisture and fungus resistant Made to MIL specifications
Operating Temperature	-55°C to +125°C
Thermal Stability	.50 ppm/°C
Attenuation	0.8 db per $\mu$ sec. approximate
Test Voltage	500 Vdc



### OPTIONAL FEATURES:

All Distributed Constant Delay Lines are offered in a choice of:  
Round or Rectangular cross-section sticks

"FD" catalog designation is for Round  $\frac{1}{32}$ " O.D. stick

"FDS" catalog designation is for Rectangular  $\frac{3}{8}$ " x  $\frac{1}{2}$ " stick

Pigtail or pin leads

Stud or insert mounting (FDS line only)

Tap points to your requirements

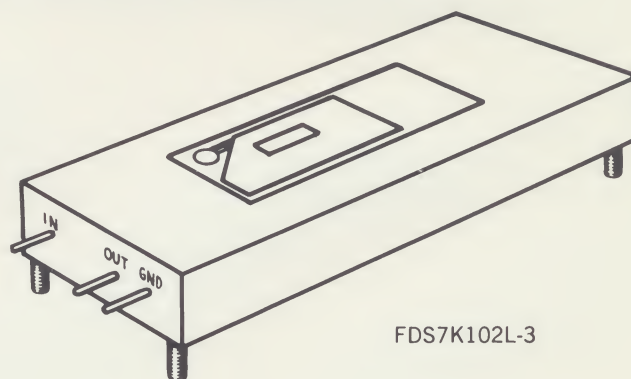
- LOWEST COST—RELIABLE PERFORMANCE
- SMALL SIZE, LIGHT WEIGHT
- IMPEDANCES: 200 TO 4000 $\Omega$
- BANDWIDTHS TO 20 Mc/s
- LINEAR PHASE SHIFT

Delay $\mu$ sec $\pm 5\%$	Rise Time Less than $\mu$ sec*	CHARACTERISTIC IMPEDANCE $\Omega \pm 10\%$						
		300 (D)	500 (F)	1000 (K)	1500 (L)	2000 (M)	3000 (N)	4000 (Q)
.1	.014	FD7D101B	FD7F101B	FD7K101B	FD7L101B	FD7M101C	FD7N101C	FD7Q101C
.2	.029	FD7D201C	FD7F201C	FD7K201C	FD7L201C	FD7M201D	FD7N201D	FD7Q201D
.3	.043	FD7D301D	FD7F301D	FD7K301D	FD7L301D	FD7M301E	FD7N301E	FD7Q301E
.4	.057	FD7D401E	FD7F401E	FD7K401E	FD7L401E	FD7M401F	FD7N401F	FD7Q401F
.5	.071	FD7D501F	FD7F501F	FD7K501F	FD7L501F	FD7M501G	FD7N501G	FD7Q501G
.6	.085	FD7D601G	FD7F601G	FD7K601G	FD7L601G	FD7M601H	FD7N601H	FD7Q601H
.7	.10	FD7D701H	FD7F701H	FD7K701H	FD7L701H	FD7M701J	FD7N701J	FD7Q701J
.8	.115	FD7D801J	FD7F801J	FD7K801J	FD7L801J	FD7M801K	FD7N801K	FD7Q801K
.9	.130	FD7D901K	FD7F901K	FD7K901K	FD7L901K	FD7M901L	FD7N901L	FD7Q901L
1.0	.14	FD7D102L	FD7F102L	FD7K102L	FD7L102L	FD7M102M	FD7N102M	FD7Q102M
1.5	.21	FD7D152M	FD7F152M	FD7K152M	FD7L152M	FD7M152N	FD7N152N	FD7Q152N
2	.40	FD5D202J	FD5F202J	FD5K202J	FD5L202J	FD5M202K	FD5N202M	FD5Q152Q
4	.80	FD5D402N	FD5F402N	FD5K402N	FD5L402N	FD5M402P		

Longer delays than shown are provided by enclosing several sticks in one case.

e.g. 3  $\mu$ sec, using FDS7K102L-3, dimensions will be  $\frac{3}{8}$ " x  $1\frac{1}{2}$ " x 6"  
10  $\mu$ sec, using FDS7K102L-10, dimensions will be  $\frac{3}{4}$ " x  $2\frac{1}{2}$ " x 6"

NOTE: number of sticks is designated by the numeral following the dash at the end of the catalog #. Thus FDS7K102L-3 designates 3 sticks.



FDS7K102L-3

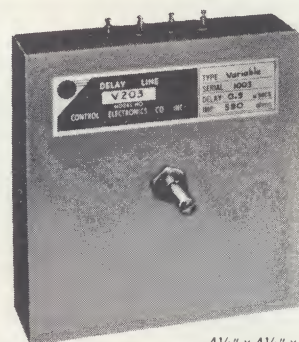


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# Variable Delay Lines

- **CONTINUOUS ROTATION**, or with mechanical stop
- **SUITABLE FOR MOTOR DRIVE**—we will supply units with motor drive to meet your specification



4 1/4" x 4 1/4" x 1 1/4"

Model V203

## TYPICAL CHARACTERISTICS\*

Model	Time Delay	Steps	Impedance (Ohms)	Rise Time	Attenuation	Max. Input (Volts)
V203	0.5 μsec	4.2 nsec	580	35 nsec	.5 db	500
V226	0-120 nsec	1 nsec	100	15 nsec	.5 db	500
V227	0-0.3 μsec	2.5 nsec	100	25 nsec	1 db	500
V228	0-0.3 μsec	2.5 nsec	5000	40 nsec	2 db	500
V229	0-1.2 μsec	10 nsec	2500	150 nsec	1 db	500
V230	0-3.0 μsec	25 nsec	1000	250 nsec	1 db	500
V231	0-12 μsec	100 nsec	250	750 nsec	6 db	300
V710	0-6 μsec	50 nsec	1000	300 nsec	2 db	500
V743	0-.1 μsec	0.833 nsec	75	15 nsec	.5 db	500
V745	0-5 μsec	42 nsec	100	250 nsec	2 db	500

\*Characteristics can be varied to suit your needs.

Control Electronics' miniature series of rotary variable delay lines are 1" high and only 3" in dia. These lines are ruggedly constructed and hermetically sealed to provide high reliability and a long service life. The delay variation is selected by a 60 position shorting type rotary switch. This shorting feature provides an intermediate delay of 1/3 step so that the resolution is one part in 120. This switch, designed by Control Electronics, can be motor driven at speeds in excess of 10 rpm, and has been life tested for over 1,000 hours of continuous use.



Model V397

Model	Time Delay	Rise Time	Impedance (Ohms)	Attenuation
V364	0 to .1 μsec	.01 μsec	50	.5 db
V365	0 to .2 μsec	.01 μsec	50	1 db
V390	0 to 3.0 μsec	.25 μsec	750	2 db
V397	0 to 1.2 μsec	.10 μsec	1000	1 db
V440	0 to 1.5 μsec	.15 μsec	500	2 db



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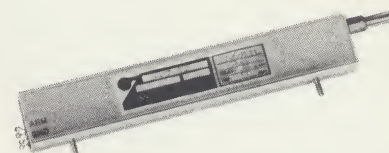
# Variable Delay Lines

- **RESOLUTION:** Better than .001  $\mu$ sec.
- Can be terminated externally or internally.
- All models are hermetically sealed.

- Can be operated above ground potential.
- **DC WORKING VOLTS:** 500 volts max.
- High impedance tap (variable)

Model	Min. Delay at Max. Delay Setting	Maximum Pulse Rise Time*	Impedance (Ohms)
VR 900	.10 $\mu$ sec	.025 $\mu$ sec	100
VR 901	.20 $\mu$ sec	.030 $\mu$ sec	200
VR 902	.70 $\mu$ sec	.080 $\mu$ sec	500
VR 903	.95 $\mu$ sec	.090 $\mu$ sec	500
VR 904	.50 $\mu$ sec	.055 $\mu$ sec	750
VR 905	.40 $\mu$ sec	.040 $\mu$ sec	1000
VR 906	.25 $\mu$ sec	.030 $\mu$ sec	1300
VR 907	.20 $\mu$ sec	.030 $\mu$ sec	1500

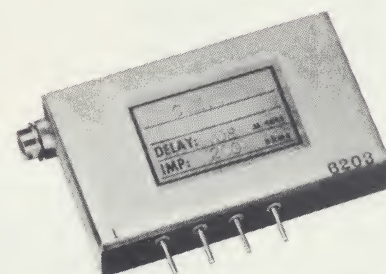
\*Rise time at maximum delay setting.



- **ATTENUATION:** Less than 1.5 db.
- **OPERATION:** Continuously variable shaft rotation of 10 turns from zero to maximum delay
- **OUTSIDE DIMENSIONS:**  $7\frac{1}{2} \times \frac{3}{4} \times 1\frac{1}{4}$
- Locking device optional at no extra charge

Model	Min. Delay at Max. Delay Setting	Maximum Pulse Rise Time*	Impedance (Ohms)
VS 950	0.75 $\mu$ sec	0.25 $\mu$ sec	390
VS 951	0.62 $\mu$ sec	0.206 $\mu$ sec	470
VS 952	0.50 $\mu$ sec	0.16 $\mu$ sec	560
VS 953	0.37 $\mu$ sec	0.125 $\mu$ sec	680
VS 954	0.25 $\mu$ sec	0.085 $\mu$ sec	1000
VS 955	0.125 $\mu$ sec	0.042 $\mu$ sec	1000
VS 956	0.062 $\mu$ sec	0.021 $\mu$ sec	1500
VS 957	0.125 $\mu$ sec	0.042 $\mu$ sec	1800
VS 958	0.080 $\mu$ sec	0.027 $\mu$ sec	200

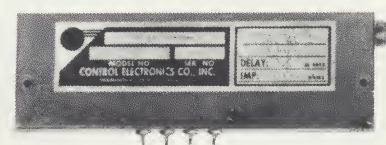
\*Rise time at maximum delay setting.



- **ATTENUATION:** 0.5 db max.
- **OPERATION:** Continuously variable shaft rotation of  $2\frac{1}{2}$  turns from zero to maximum delay.
- **OUTSIDE DIMENSIONS:**  $2\frac{3}{8} \times \frac{1}{2} \times 1\frac{1}{2}$

Model	Min. Delay at Max. Delay Setting	Maximum Pulse Rise Time*	Impedance (Ohms)
VL 1000	1.50 $\mu$ sec	.30 $\mu$ sec	390
VL 1001	1.25 $\mu$ sec	.25 $\mu$ sec	470
VL 1002	1.0 $\mu$ sec	.20 $\mu$ sec	560
VL 1003	0.75 $\mu$ sec	.15 $\mu$ sec	680
VL 1004	0.50 $\mu$ sec	.10 $\mu$ sec	1000
VL 1005	0.25 $\mu$ sec	.04 $\mu$ sec	1000
VL 1006	0.125 $\mu$ sec	.03 $\mu$ sec	1500
VL 1007	0.25 $\mu$ sec	.06 $\mu$ sec	1800

\*Rise time at maximum delay setting.



- **ATTENUATION:** Less than 1.0 db.
- **OPERATION:** Continuously variable shaft rotation of 5 turns from zero to maximum delay.
- **OUTSIDE DIMENSIONS:**  $4\frac{3}{4} \times \frac{1}{2} \times 1\frac{1}{2}$



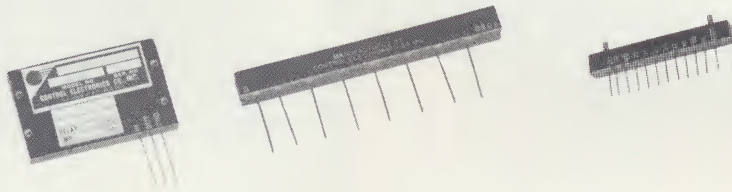
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LC -6401

## Miniature Tapped Delay Lines

- **DELAY TOLERANCE:**  $\pm 3\%$  or  $\pm .01 \mu\text{sec}$
- **TAPS:** 10, equally spaced
- **THERMAL STABILITY:** 45ppm/ $^{\circ}\text{C}$
- **TEST VOLTAGE:** 500 Vdc
- **WORKING VOLTAGE:** 300 Vdc
- **PULSE VOLTAGE:** 50 volts peak
- **TEMPERATURE RANGE:**  $-50^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$
- **LEADS:** #22 AWG tinned copper or brass



LC-6402

Delay $\mu\text{sec.}$	Maximum Output Rise Time $\mu\text{sec.}$	Bandwidth Mc/s	Impedance Range (Ohms)	Dimensions (inches)
0.05	.008	64	50-100	$\frac{1}{2} \times \frac{1}{2} \times 3$
0.1	.014	32	50-200	$\frac{1}{2} \times \frac{1}{2} \times 3$
0.2	.028	16	100-400	$\frac{1}{2} \times \frac{1}{2} \times 3$
0.3	.043	12	50-500	$\frac{1}{2} \times \frac{1}{2} \times 3$
0.4	.057	9	60-600	$\frac{1}{2} \times \frac{1}{2} \times 3$
0.5	.072	6.4	80-800	$\frac{1}{2} \times \frac{1}{2} \times 3$
0.6	.085	5.3	100-1000	$\frac{1}{2} \times \frac{1}{2} \times 3$
0.7	.1	4.6	100-1500	$\frac{1}{2} \times \frac{1}{2} \times 3$
0.8	.115	4	100-2000	$\frac{1}{2} \times \frac{1}{2} \times 3$
0.9	.129	3.5	100-2000	$\frac{1}{2} \times \frac{1}{2} \times 3$
1	.145	3.2	200-2000	$\frac{1}{2} \times \frac{1}{2} \times 3$
2	.286	1.6	250-1500	$\frac{1}{2} \times \frac{1}{2} \times 3$
3	.428	1.06	300-2000	$\frac{1}{2} \times \frac{3}{4} \times 3$
4	.57	0.82	500-1000	$\frac{1}{2} \times \frac{3}{4} \times 3$
5	.715	0.63	400-1000	$\frac{1}{2} \times \frac{3}{4} \times 3$
6	.85	0.53	500-1000	$\frac{1}{2} \times \frac{3}{4} \times 3$
7	.95	0.455	600-1000	$\frac{1}{2} \times \frac{3}{4} \times 3$
8	1.05	0.40	1000	$\frac{1}{2} \times \frac{3}{4} \times 3$
9	1.25	0.35	750	$\frac{1}{2} \times \frac{3}{4} \times 3$
10	1.4	0.32	500	$\frac{1}{2} \times \frac{3}{4} \times 3$

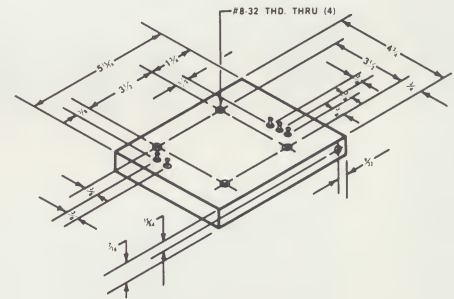
## Compact Magline

Model	Delay	Adj. From Center Delay	Max. Pulse Rep. Rate	Attenuation
FM 401 Commercial 402 Military	50 to 1200 $\mu\text{sec}$	$\pm 4 \mu\text{sec}$	1 Mc/s	55-65 db

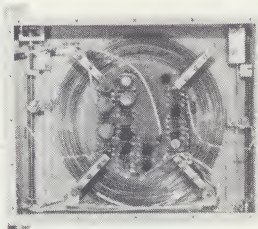
### TYPICAL CHARACTERISTICS:

1. Input impedance  $50\Omega$  to  $2000\Omega^*$
2. Output termination  $50\Omega$  to  $5K\Omega^*$
3. Signal to noise ratio 20:1
4. Change in delay with temp.  $1 \times 10^{-5} \frac{\mu\text{SEC}}{^{\circ}\text{C}}$  nominal  
 $1 \times 10^{-6} \frac{\mu\text{SEC}}{^{\circ}\text{C}}$  on order

\*Specify when ordering



## Magline Memory Systems



Model	Delay	PRR	S/N	Input Level
FMS 4013	5000 $\mu\text{sec}$	250 Kc/s	26 db	3-15 V
FMS 4037	4400 $\mu\text{sec}$	650 Kc/s	32 db	3-15 V
FMS 4047	250 $\mu\text{sec}$	340 Kc/s	20 db	5 V
FMS 4066	3500 $\mu\text{sec}$	850 Kc/s	35 db	6 V



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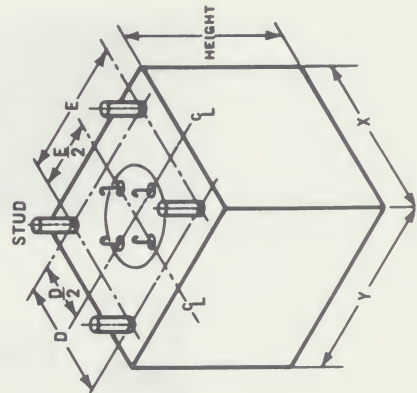
# Lumped Constant Delay Lines

## STANDARD UNITS

## BUILT TO MIL SPECIFICATIONS

Time Delay $\mu s$	50(A)	100(C)	500(F)	1,000(K)	1,500(L)	2,000(M)	3,000(N)	5,000(R)	7,500(R)	10,000(T)
Code	Code	Code	Code	Code	Code	Code	Code	Code	Code	Code
.25	F17A251AE F10A251AE F5A251AA	F17C251AE F10C251AE F5C251AA	F17F251AE F10F251AE F5F251AA			F5M251AE	F5N251AE			
.50	F17A501AE F10A501AE F5A501AA	F17C501AE F10C501AE F5C501AA	F17F501AE F10F501AE F5F501AA	F5K501AE	F5L501AE	F10M501CC F5M501AE	F5N501AE			
1.0	F33A102CE F20A102CC F10A102AE F5A102AE	F33C102CE F20C102CC F10C102AE F5C102AE	F33F102CE F20F102CC F10F102CC F5F102AE	F10K102CC F5K102CC	F5L102CC	F10M102CC F5M102AE	F10N102CC F5N102AE	F5P102		
1.5	F30A152CE F20A152CC F10A152AE F5A152AE	F30C152CE F20C152CC F10C152AE F5C152AE	F30F152CE F20F152CC F10F152CC F5F152AE							
5.0	F33A502EF F20A502DE F10A502CC F5A502CE	F33C502EE F20C502CE F10C502CE F5C502CC	F33F502GD F20F502DE F10F502DE F5F502AE	F33K502GD F20K502JC F10K502CC F5K502AE	F10L502DE F5L502CC	F20M502DE F10M502CC F5M502AE	F20N502DE F10N502CC F5N502AE	F20P502DE F10P502CC F5P502AE	F10R502CC F5R502AE	F5T152AE
10.0	F33A103GE F20A103EE F10A103CE F5A103CE	F33C103GD F20C103DE F10C103DE F5C103CC	F33F103GD F20F103GE F10F103CC F5F103AE	F33K103JD F20K103DE F10K103CC F5K103AE	F10L103JD F20L103DE F10L103CC F5L103AE	F33M103GD F20M203DE F10M103CC F5M103AE	F33N103GD F20N103DE F10N103CC F5N103AE	F20P103DE F10P103CC F5P103AE	F10R103CC F5R103AE	F10T103CC F5T103AE
20.0	F33A203GE F20A203GF F10A203EF F5A203CE	F33C203JC F10C203GD F10C203DE F5C203CC	F33F203GD F20F203DE F10F203CE F5F203CC	F33K203GD F20K203DE F10K203CE F5K203AE	F33L203GD F20L203DE F10L203CC F5L203AE	F33M203GD F20M203DE F10M203CC F5M203AE	F33N203GD F20N203DE F10N203CC F5N203AE	F33P203GD F20P203DE F10P203CC F5P203AE	F20R203DE F10R203CC F5R203AE	F20T203DE F10T203CC F5T203CC
50.0	F33A503JF F20A503JC F10A503GE F5A503CE	F33C503JD F20C503JD F10C503DE F5C503CE	F33F503GF F20F503EF F10F503CE F5F503CC	F33K503GD F20K503EF F10K503CE F5K503CC	F33L503GD F20L503DE F10L503CE F5L503AE	F33M503GD F20M503DE F10M503CC F5M503AE	F33N503GD F20N503DE F10N503CC F5N503AE	F33P503GD F20P503DE F10P503CC F5P503AE	F33R503GD F20R503DE F10R503CC F5R503CC	F33T503GD F20T503DE F10T503CC F5T503CC
100	F33A104JG F10A104GE	F33C104JF F10C104DE	F33F104GF F10F104CE	F33K104GF F10K104CE	F33L104GF F10L104CE	F33M104GD F10M104AE	F33N104GD F10N104AE	F33P104GD F10P104AE	F33R104GD F10R104AE	F33T104GD F10T104AE
200	F33A204JL F10C204GD	F33C204JF F10C204GD	F33F204JF F10F204GD	F33K204JF F10K204CE	F33L204JF F10L204CE	F33M204GD F10M204AE	F33N204GD F10N204AE	F33P204GD F10P204AE	F33R204GD F10R204AE	F33T204GD
500	F33A504JL F10C504GD	F33C504JL F10C504GD	F33F504JF F10F504GD	F33K504JF F10K504GD	F33L504JF F10L504GD	F33M504GF F10M504GD	F33N504JF	F33P504JF		

TAPPED AS REQUIRED



Height Letter	Code Size
A	1 1/2"
B	2"
C	2 1/2"
D	3"
E	3 1/2"
F	4"
G	4 1/2"
H	5"
J	5 1/2"
K	6"
L	6 1/2"
M	7"

## BASE AND MOUNTING CODE

Letter	Base Size		Mounting Dimensions		Stud Size
	X	Y	D	E	
A	1 5⁄₈	1 5⁄₈	1 1⁄₈	1 1⁄₈	6-32 x 3⁄₈
C	2 5⁄₈	2 1⁄₈	1 1⁄₈	1 1⁄₈	6-32 x 3⁄₈
D	2 3⁄₄	2 3⁄₈	2 1⁄₈	1 3⁄₄	6-32 x 3⁄₈
E	3 1⁄₈	2 5⁄₈	2 1⁄₈	1 5⁄₈	8-32 x 3⁄₈
G	3 15⁄₁₆	3 3⁄₈	3	2 1⁄₈	10-32 x 1⁄₂
J	5 1⁄₂	4 1⁄₂	3 3⁄₄	3	1⁄₄-20 x 5⁄₈

Tolerance  $\pm .005$

Last letters of the catalog number indicate size.  
Example: F10F501AE (here A indicates Base, E indicates Height)

**DELAY TOLERANCE:**  
 $\pm 3\% + .01 \mu\text{sec.}$

**IMPEDANCE TOLERANCE:**  
 $\pm 10\%$

**ATTENUATION:**

Less than .2 times the delay to rise time ratio

**THERMAL STABILITY:**  
50 parts/million /°C

**OPERATING TEMPERATURE RANGE:**  
-55°C to +125°C

**SPURIOUS SIGNALS:**  
Less than 10%

# Magnetostrictive Delay Lines For Memory Systems

**SERIES FMS 5000** All solid-state circuitry, self contained for application in memory systems or cascaded systems for extra-long delays (or information capacity). Units operate in a non-return-to-zero (NRZ) mode. Amplifier restores output signal level to same strength as input.

**SERIES FMS 4000** Provides same magnetostrictive delay circuit as FMS 5000, but without the signal-restoring amplifier. Signal-to-noise ratio is 20:1, typical. Attenuation: 55 to 70 db.

## SPECIFICATIONS (FMS 5000 Series):

Delay (per unit): 50 to 4200 microseconds  
 Adjustment:  $\pm 2$  usec (trimmer adjustment with exclusive slip-clutch, non-jam feature).  
 Repetition Rate: 3.0 Mc, maximum.  
 Temperature Range: 0 - 50°C.  
 Input Power:  $\pm 12$  vdc at 75 ma; alternate  $\pm 25$  vdc at 50 ma.  
 Input Logic:  $+6 \pm 2$  vdc (logic "1"),  $0 \pm \frac{1}{2}$  vdc (logic "0"); alternate, 0 and -6 vdc.  
 Output Logic: 10 ma at same logic as input (True and False output).  
 Connector: Terminals or PC connector flying leads or as specified.  
 Accuracy: Permits cascading without signal deterioration.  
 Case: Self-enclosed.  
 Mounting: Clear-through holes.  
 Thickness: Series FMS 5000, 1"; Series FMS 4000,  $\frac{3}{4}$ ".

For complete, packaged memory systems including associated gates . . . CONSULT FACTORY



## PART NUMBER TABLE

P/N	DELAY	MAX. PULSE REP. RATE*	SIZE	PPM/°C
FMS 5051 to FMS 5101	50 usec to 100 usec	3.0 Mc	5" x 6"	5
FMS 5101 to FMS 5102	100 usec to 1000 usec	2.6 Mc	5" x 6"	1
FMS 5102 to FMS 5252	1000 usec to 2500 usec	2.3 Mc	6" x 7"	1
FMS 5252 to FMS 5422	2500 usec to 4200 usec	2.0 Mc	8" x 9"	1

\*NOTE: FMS 4000 Series (without associated circuitry) permits up to 15% improvement in Max. Pulse Rep. Rate.

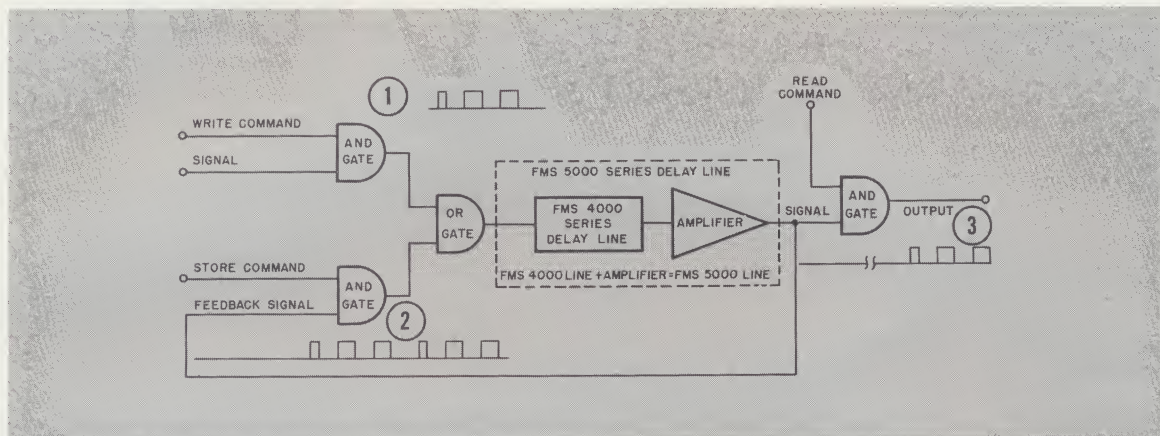


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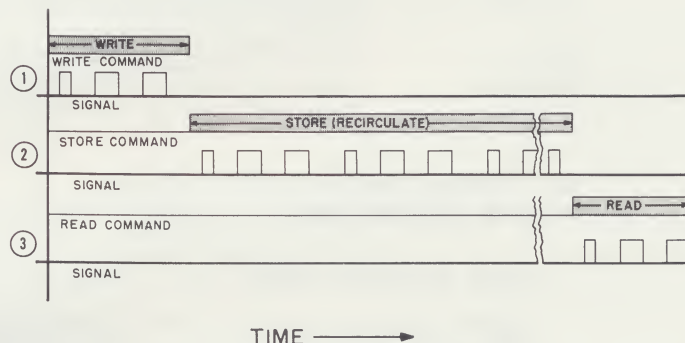
# Memory System Application

**BLOCK DIAGRAM #1 — MEMORY SYSTEM, SIMPLIFIED**

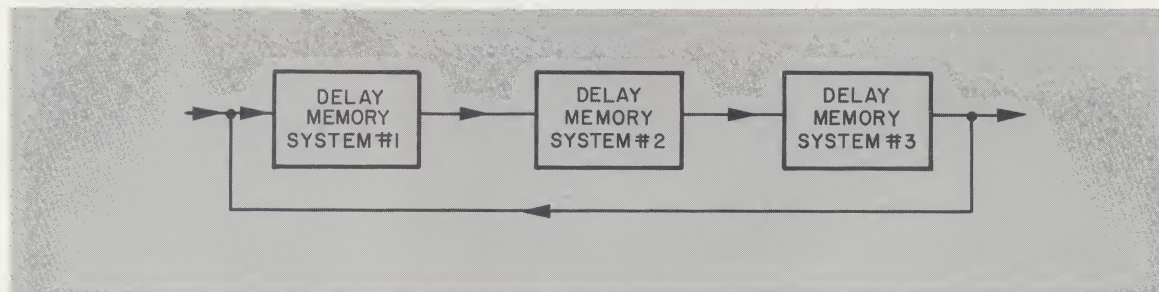


Memory systems are used to store information for intervals of time prior to reading (using) the information. For example, the output data from a computer may be delivered to a recorder too close behind the delivery of previous data. A delay line can be used to hold (store) the data until the recorder input is unloaded. See Block Diagram #1. Information may be stored, read or new data may be written in at any time.

For extremely long delays or large bit storage capacity, information is best preserved by a cascaded memory system. In this application, several Series FMS 5000 delay line memory systems are connected in series, as shown in Block Diagram #2. FMS 5000 Series outputs are compatible with (can be fed directly into) the input of another FMS Series line. Buffer stages are not required.



**BLOCK DIAGRAM #2 — CASCADED MEMORY SYSTEM**



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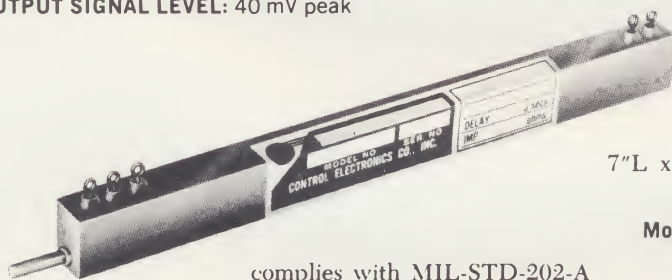
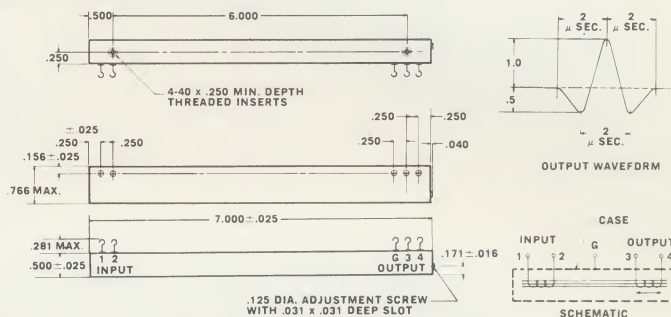
# Variable Maglines

- **TIME DELAY:** 2-22  $\mu\text{sec}$
- **OPTIMUM INPUT PULSE WIDTH:** 1.0  $\mu\text{sec} \pm .2 \mu\text{sec}$
- **MAXIMUM PRF:** 500 Kc/s
- **MAXIMUM AVERAGE POWER INPUT:** 0.1 watt
- **IMPEDANCE RANGE FOR INPUT OR OUTPUT:** 50 to 4000 ohms

Line is stocked in 700 ohm input and output impedance and has the following specific characteristics:

**MAXIMUM PULSE VOLTAGE TO REACH SATURATION LEVEL:** 40 V peak

**MAXIMUM OUTPUT SIGNAL LEVEL:** 40 mV peak

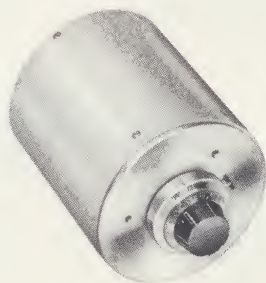


7"L x .5"W x .766"H

**Model VM1020**

complies with MIL-STD-202-A

**Model VM1030**



**Model VM1090**



MODEL VM 1030	SPECIFICATIONS	MODEL VM 1090
3 to 500 $\mu\text{sec}$	Delay Range	3 to 4000 $\mu\text{sec}$
50 ohms to 4K ohms	Impedance Range	50 ohms to 4K ohms
3 $\mu\text{sec}$	Min. Pulse Spacing	3 $\mu\text{sec}$
12 mv	Output when driven with 15 V Pk. - 1 $\mu\text{sec}$ pulse	6 mv
10	Turns for full delay	28
4" O.D. x 4.5" L	Size	9" O.D. x 3 5/8" L
2 lb.	Weight	5 lb.



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